AD-A142 870 EVALUATION OF DOMESTIC CORRUGATED FIBERBOARD BOXES TREATED WITH WATERPROO..(U) AIR FORCE PACKAGING EVALUATION AGENCY WRIGHT-PATTERSON AFB OH.. A J SICARD 1/1

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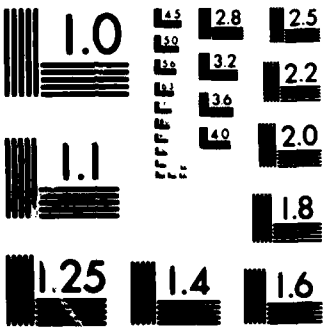

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EVALUATION OF DOMESTIC CORRUGATED FIBERBOARD BOXES TREATED WITH WATERPROOFING MATERIALS

HQ AFLC/DSTZ
AIR FORCE PACKAGING EVALUATION AGENCY
WRIGHT-PATTERSON AFB, OHIO 45433

May 1984

NOTICE

ABSTRACT

As the result of a Logistic Need (LN-SA-ALC-AFWAS/MS-1013-80-01) identified by San Antonio Air Logistics Center, Packing and Preservation Branch (SA-ALC/DSPC), the Air Force Packaging Evaluation Agency (AFPEA) initiated an investigation to determine the feasibility of upgrading (treating) at the base and depot level commercial domestic fiberboard boxes containing supplies required to support rapid deployment of military forces. Subsequent investigation of several commercial products led to the evaluation of a macroencapsulated coating called MACAP- a two part polymer resin and cross-linking hardener having extremely low water and water vapor transmission properties.

SUMMARY

Based on the comparative test results of untreated, brush and spray treated domestic fiberboard containers subjected to high humidity environmental conditions (100°F, 95% R.H.), MACAP had little significant effect on increasing the compressive strengths of the treated containers. Consequently, further consideration of this approach was not considered warranted.

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INTRODUCTION

San Antonio Air Logistics Center (SA-ALC/DSPC), through the submission of a Logistic Need (LN-SA-ALC-AFWAL/ML-1013-80-01), requested the Air Force Packaging Evaluation Agency (AFPEA) to investigate the feasibility of upgrading (treating) commercial domestic fiberboard boxes containing supplies required to support rapid deployment of military forces. Although, numerous government and industry studies have been performed in the past with the objective of improving the weather-resistant strength properties of domestic fiberboard, none have had any significant success. However, AFPEA decided to support the SA-ALC/DSPC request and conduct further investigations in this area because of the recent development of new products that might be suitable for water-proofing domestic fiberboard. Subsequent investigation of several commercial products led to the evaluation of a macroencapsulated application called MACAP - a proprietary product developed by Capsulated Systems Inc. (CSI), Fairborn, Ohio. The CSI system consisted of a two part polymer resin and cross-linking hardener having extremely low water and water vapor transmission properties. The product was primarily developed to protect solid-state electronic components that are susceptible to deterioration due to moisture.

APPROACH

The Mullen Burst and Short Column Strength Tests were conducted to compare the performance of treated versus untreated, singlewall and doublewall, domestic corrugated fiberboard samples prior to testing complete containers. The materials in samples which indicated a significant increase in compressive strength, 50% or more, after exposure to high humidity environmental conditions (100°F, 95% RH), were then evaluated in the form of complete containers.

The procedure used in this study, compared the performance of treated samples against untreated samples under similar environmental conditions. The percentages indicated in Table 1, are the results of these comparisons.

DESCRIPTION OF TEST SAMPLES

Test samples were cut, and regular slotted containers (RSC) were constructed from domestic grade, single and doublewall corrugated fiberboard. The class, grade and flute size conformed to specification PPP-F-320D. Samples and containers requiring MACAP treatment were treated by Capsulated Systems Inc., prior to testing. The samples were brush coated twice, with five minute intervals between coats, on all surfaces and edges. The RSC containers were either spray or brush coated twice, with five minute intervals between coats, on all inner and outer surfaces including edges.

EQUIPMENT

The following equipment were employed in this study:

1. Tensile Compression Tester, Instron, Model TTC.

2. Mullen Burst Tester, B.F.Perkins & Sons Inc.

3. High Temperature/Humidity Test Chamber, Standard Environmental Systems Inc., Model Smith/960.

TEST PROCEDURES

Short Column Test (Compressive Strength)

The short column test was conducted in accordance with Method 2033 of Federal Test Method Standard (FTMS) 101C. Sets of ten samples each, 1 1/4" x 2", treated and untreated, singlewall and doublewall fiberboard were conditioned at ambient temperature (70°F, 50% RH) for a period of seven days prior to testing. Duplicate sets of fiberboard samples were conditioned at 100°F, 95% RH for seven days. During testing, the crosshead movement rate of the compression machine was a constant 0.5 inch per minute. Comparative test results for the two conditioning environments are presented in Charts 1 and 2. The load bearing edges of each sample were sealed with parafin to a depth of 1/4 inch prior to conditioning.

Dry and Wet Bursting Strength

The dry and wet bursting strength tests were conducted, respectively, in accordance with procedure B, Test Method 2007.1 of FTMS 101C and specification PPP-F-320D. Sets of five samples each, 6" x 10", treated and untreated, singlewall and doublewall fiberboard were conditioned at ambient temperature (70°F, 50% RH) for seven days prior to testing. Duplicate sets of fiberboard samples were submerged in fresh aerated tap water at a temperature of 75°F ±5°F, and a ph value between 6.5 and 7.5 for a period of 24 hours. Comparative test results are presented in Charts 3 and 4.

Compression Test for Shipping Containers

Compression tests of the fiberboard containers were conducted in accordance with ASTM D642-76. Sets of two each RSC containers, 15 inch cube, singlewall, treated and untreated, constructed in accordance with PPP-B-636, were conditioned at ambient conditions of 70°F, 50% RH for a period of seven days prior to testing. For comparative testing similar sets of RSC containers were conditioned at 100°F, 95% RH for a period of 31 days. During testing, the crosshead movement rate of the compression machine was a constant 0.5 inch per minute. Comparative test results are presented in Chart 5.

RESULTS

The comparative test results are summarized in Table 1. MACAP treatment significantly increased the short column compression and bursting strengths of singlewall fiberboard; however, only a modest increase in compression strength occurred in treated singlewall RSC containers.

DISCUSSION/CONCLUSIONS

MACAP as a barrier resin coating had some effect in delaying the penetration by moisture of the cellulosic fibers of the domestic grade singlewall fiberboard. This was evident in the modest 11% and 24% compressive strength increases of brush and spray coated containers which were exposed to high humidity environmental conditions for 31 days. However, the slight increase in compression performance is not considered significant because further deterioration of these containers could be expected in actual field environments where high humidity conditions are common over extended periods far in excess of 31 days.

Although MACAP had little effect on increasing the compression strength of a

container it should be noted that there was a significant increase in the Wet Mullen burst strength of fiberboard. This could have a beneficial effect on the ability of a container to withstand impact due to handling.

Complete doublewall fiberboard containers weren't evaluated because the comparative short column compressive strength of treated specimens indicated no increase in strength after exposure to high humidity conditions.

TABLE 1. RESULTS OF COMPRESSIVE STRENGTH TESTS OF TREATED VERSUS UNTREATED FIBERBOARD SPECIMENS.

TEST	FIBERBOARD SPECIMENS	CONDITIONING	UNTREATED STRENGTH	Treated STRENGTH	PERCENT INCREASE
SHORT COLUMN COMPRESSION STRENGTH TEST IAW METHOD 2033 OF FTMS 101C	SINGLEWALL; SIZE 1 1/4" x 2"	AMBIENT [1]	73 lbs	235 lbs	222% [4]
		HIGH HUMIDITY [2]	49 lbs	77 lbs	57%
	DOUBLEWALL; SIZE 1 1/4" x 2"	AMBIENT	121 lbs	193 lbs	60%
		HIGH HUMIDITY	72 lbs	62 lbs	-14% [5]
BURSTING STRENGHT TEST IAW METHOD 2007.1 OF FTMS 101C AND PPP-F-320D	SINGLEWALL; SIZE 6" x 10"	AMBIENT	145 PSI	478 PSI	230%
		HIGH HUMIDITY	9 PSI	450 PSI	4900%
	DOUBLEWALL; SIZE 6" x 10"	AMBIENT	216 PSI	267 PSI	24%
		HIGH HUMIDITY	16 PSI	377 PSI	2256%
BOX COMPRESSION STRENGTH TEST IAW ASTM D642-76	SINGLEWALL RSC CONTAINER CONSTRUCTED IAW PPP-B-636; SIZE 15" CUBE	AMBIENT	1270 lbs	1715 lbs [3]	35%
			1270 lbs	1515 lbs	19%
		HIGH HUMIDITY	695 lbs	860 lbs	24%
			695 lbs	770 lbs	11%

NOTES:

1. Ambient Condition: 70°F, 50% RH.
2. High Humidity Condition: 100°F, 95% RH.
3. Samples were spray coated whereas all other treated samples were brush coated.
4. Percentages above 50% were considered significant results.
5. The apparent reduction in strength of the treated samples may be due to either variations in the properties from which the specimens were cut or deviations in the test procedure.

CHART 1.

Short Column Test (Compressive Strength)

Method 2033 of FTMS 101C

Specimen: Domestic Corrugated Fiberboard, Grade 200 (Singlewall)

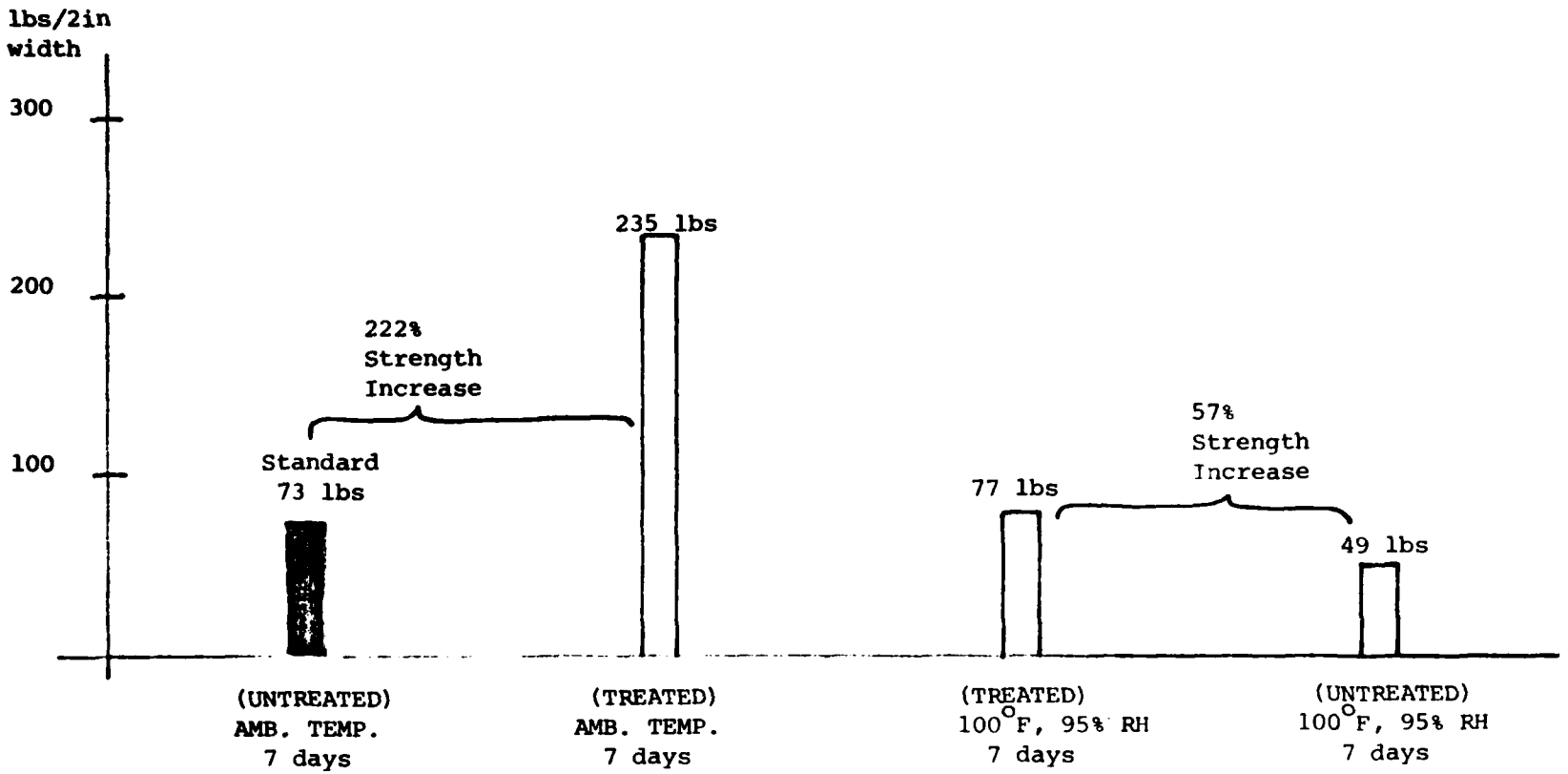


CHART 2.
SHORT COLUMN TEST (COMPRESSIVE STRENGTH)
METHOD 2033 OF FTMS 101C
SPECIMEN: DOMESTIC CORRUGATED FIBERBOARD, GRADE 275 (DOUBLEWALL)

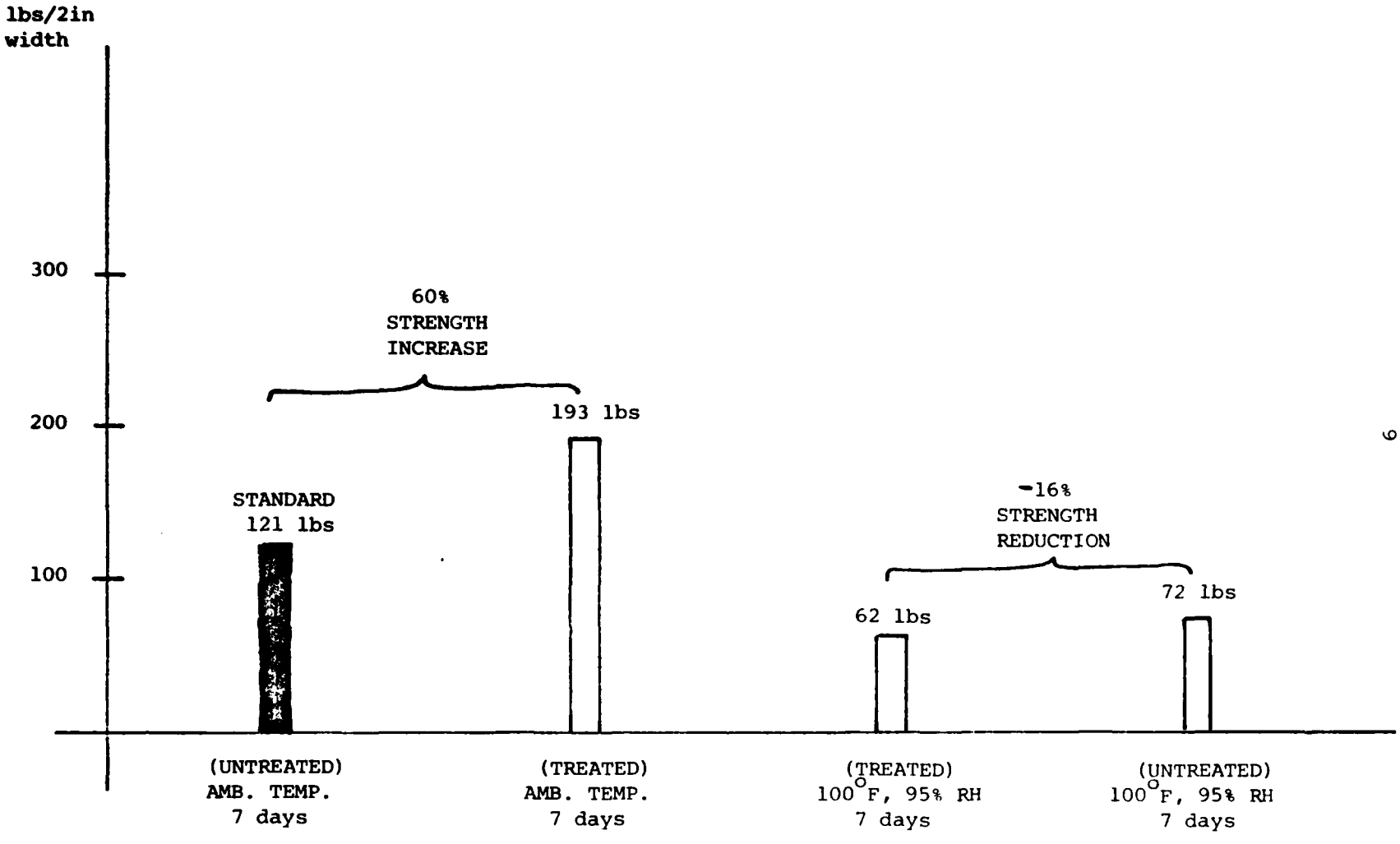


CHART 3.

DRY AND WET BURSTING STRENGTH TEST
METHOD 2007.1 OF FTMS 101C & SPECIFICATION PPP-F-320D
SPECIMEN: DOMESTIC CORRUGATED FIBERBOARD GRADE 200 (SINGLEWALL)

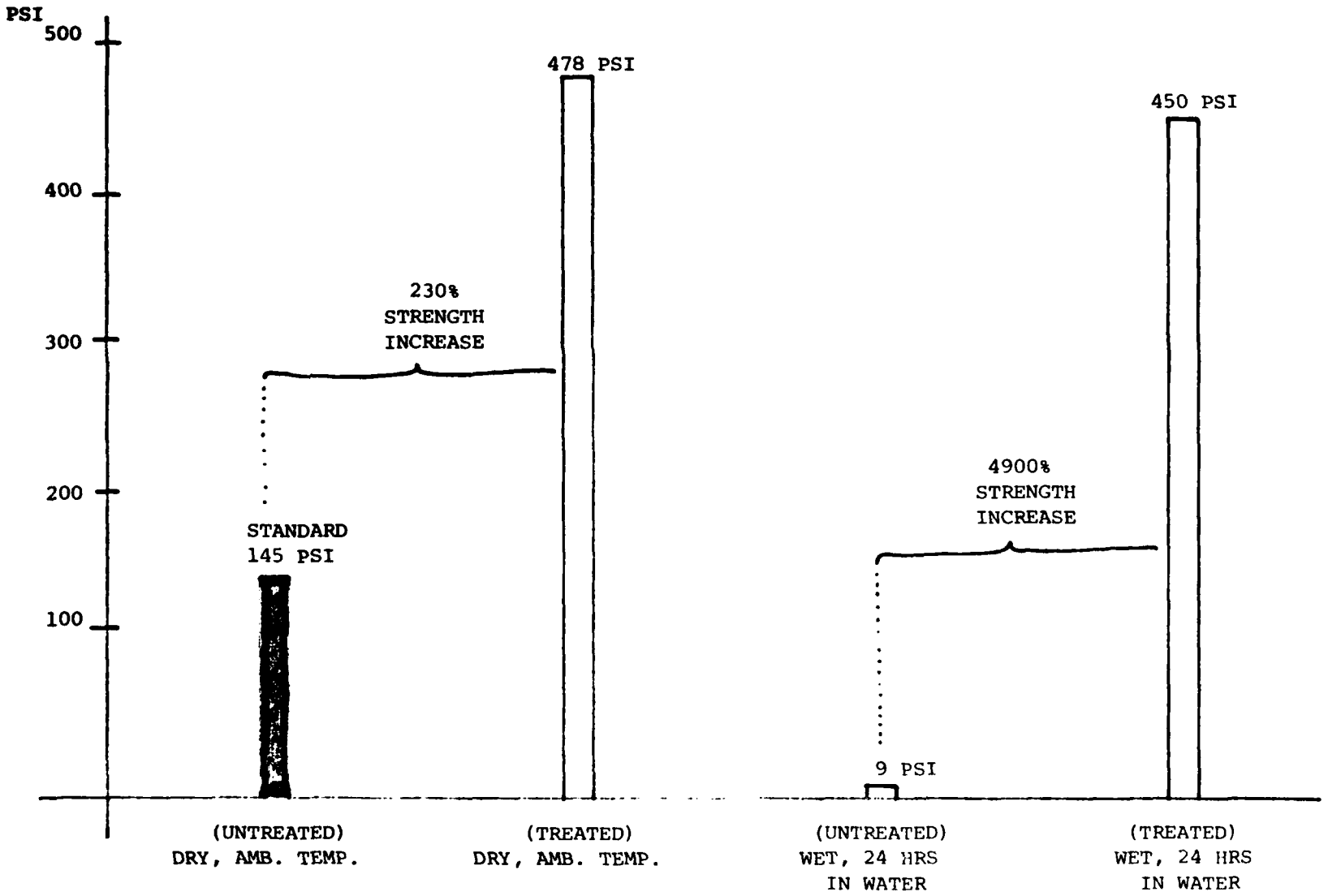


CHART 4.
DRY AND WET BURSTING STRENGTH TEST
METHOD 2007.1 OF FTMS 101C & SPECIFICATION PPP-F-320D
SPECIMEN: DOMESTIC CORRUGATED FIBERBOARD GRADE 275 (DOUBLEWALL)

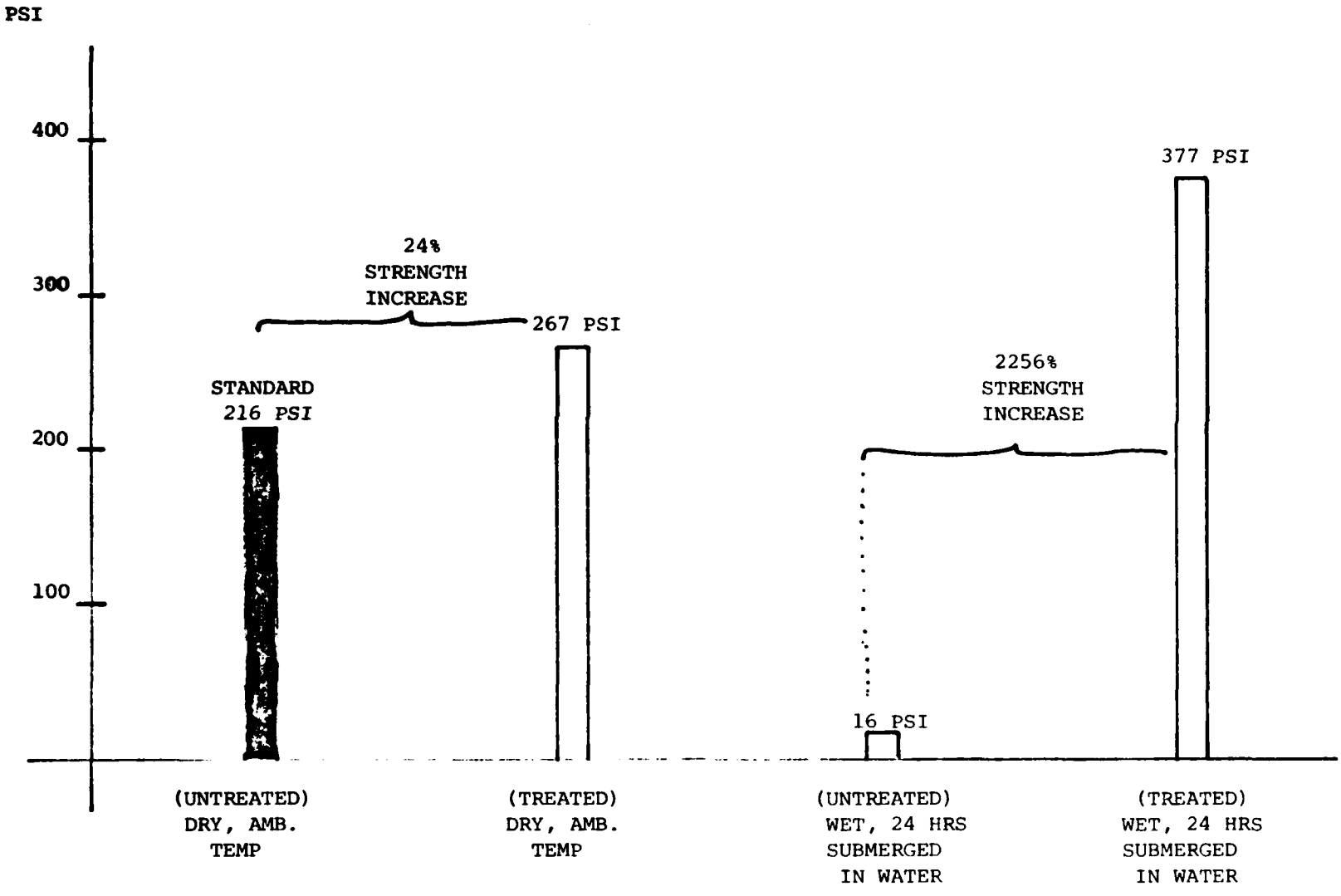
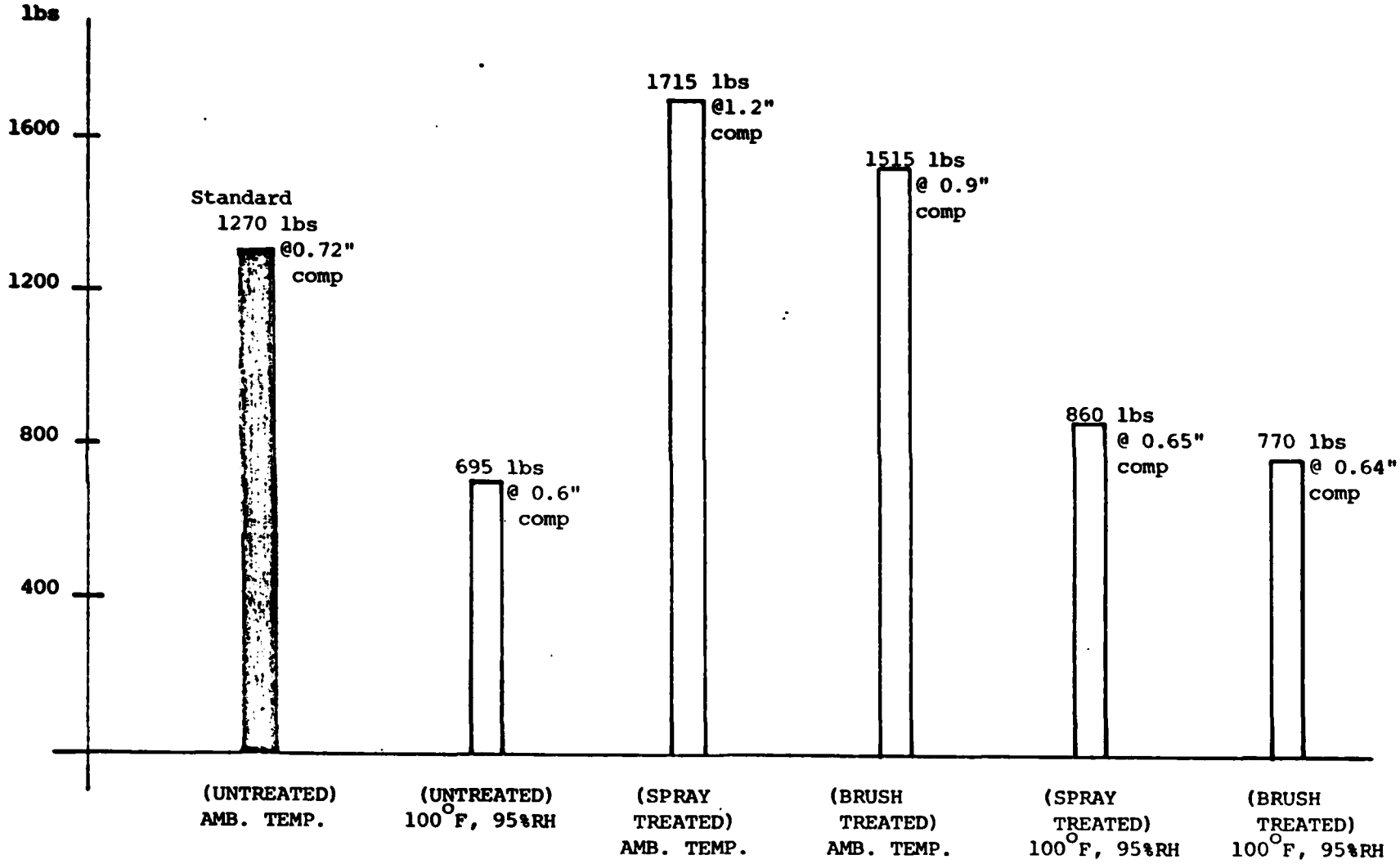


CHART 5.
CONTAINER COMPRESSION STRENGTH TEST
ASTM D642-76
SPECIMEN: RSC DOMESTIC SINGLEWALL CORRUGATED FIBERBOARD CONTAINER



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In support of the San Antonio Air Logistics Center (DSPC), the Air Force Packaging Evaluation Agency (AFPEA) investigated the feasibility of upgrading (treating) on site in the field, level B and domestic fiberboard boxes containing supplies required to support rapid deployment of military forces. Consequent investigation of several commercial products led to the evaluation of a polymer resin coating called MACAP, which was developed to protect solid-state electronic components that are susceptible to deterioration due to moisture. Based on comparative compressive strengths of treated and untreated domestic containers tested under high humidity conditions, MACAP wasn't effective in adequately protecting the fiberboard from moisture transmission.

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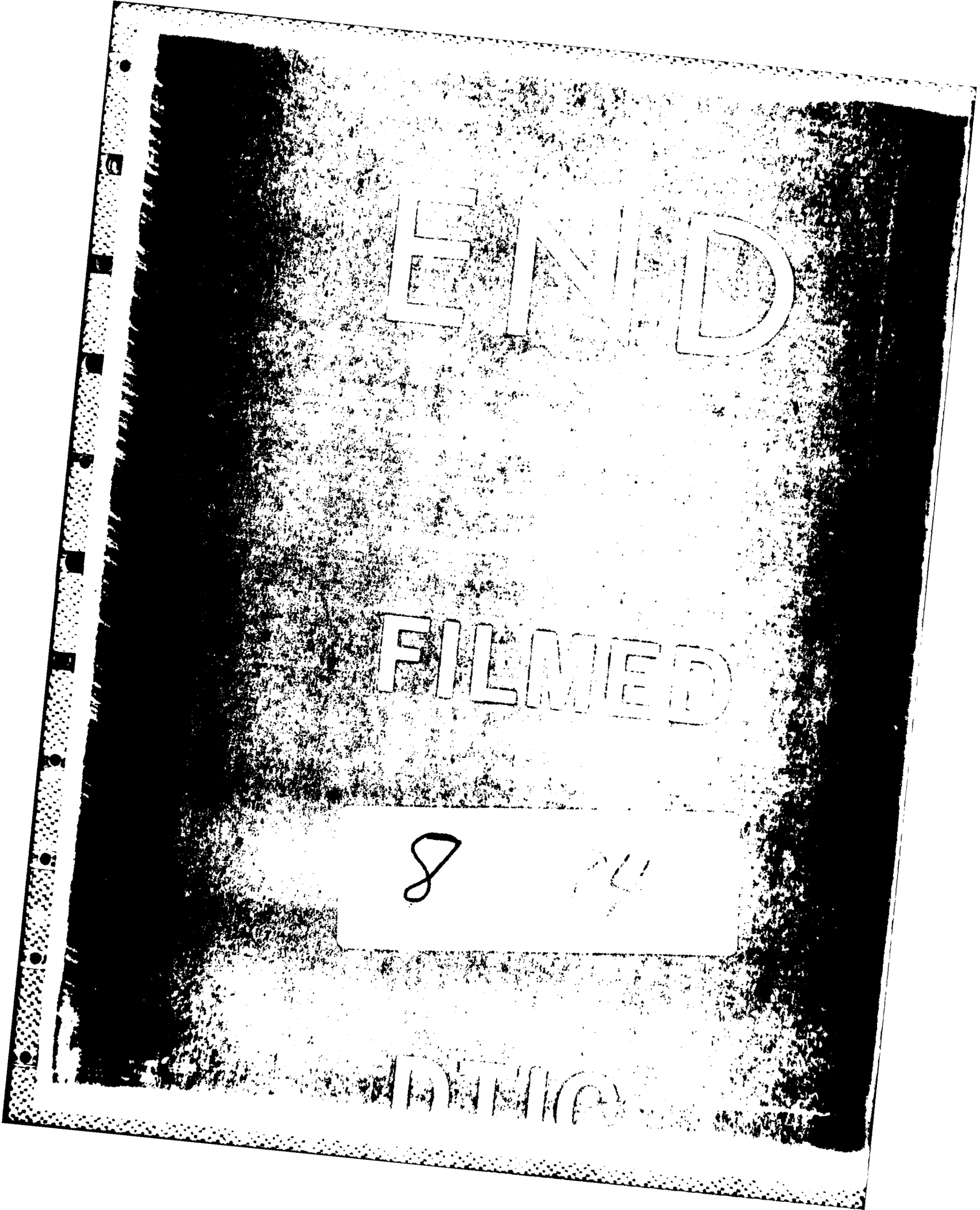
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